A 24: Ultra-Cold Atoms, Ions and BEC II (with Q)

Zeit: Donnerstag 10:30–12:15 Raum: VMP 6 HS-C

Fachvortrag A 24.1 Do 10:30 VMP 6 HS-C

Towards surface quantum optics with Bose-Einstein condensates in evanescent waves — Helmar Bender, Philippe Courteille, Claus Zimmermann, and •Sebastian Slama — Physikalisches Institut, Eberhard-Karls-Universität Tübingen, Auf der Morgenstelle 14, D-72070 Tübingen

I will speak about the interaction of ultracold atoms with surfaces. This topic is very interesting for several reasons, for example from a fundamental point of view for the measurement of van der Waals like surface potentials and the understanding of surface effects like adsorption. From a quantum optical point of view it is interesting to coherently couple atomic matter waves with evanescent light waves for nondestructive atom detection with the prospect of QND measurements of atom numbers. Evanescent light waves are also interesting for technological reasons because by the use of surface plasmons it might be possible to produce nanostructured surface traps. In Tübingen we have made a first step towards these goals and have set up an experiment in which we bring Bose-Einstein condensates very close to the surface of a glass prism. We are able to position the atoms in a controlled way to distances from the surface below one micrometer by loading them into a combined magnetic and evanescent wave surface trap. I will present first measurements with our setup and discuss our plans for the future.

A 24.2 Do 11:00 VMP 6 HS-C

Dissipative processes of a trapped atom approaching conditions of electromagnetically induced transparency — •Maryam Roghani, Heinz-Peter Breuer, and Hanspeter Helm — University of Freiburg, Hermann-Herderstr. 3,D-79104 Freiburg, Germany

We study a three-level atom trapped in a one-dimensional quantum mechanical harmonic oscillator, interacting with two counter-propagating laser beams. Atom-light interaction leads to an entangled state of electronic and vibrational degrees of freedom. We show that by prudent choice of experimental parameters the atom approaches EIT-like (Electromagnetically Induced Transparency) conditions as it is cooled down to the lowest level of the trap [1], even beyond the Lamb-Dicke limit. Solving numerically the master equation gives us the opportunity to derive from the time-dependent density matrix elements the evolution of transparency and entanglement, together with the force and dissipation terms which are active in the removal of translational energy from the trapped atom. This scheme may find application in the purely optical preparation of Bose-Einstein condensates without evaporative cooling and also in the laser-cooling of macroscopic objects of crystalline matter. [1]. Trapped-Atom Cooling Beyond The Lamb-Dicke Limit Using Electromagnetically-Induced Transparency, M. Roghani and H. Helm , Physical Review A 77, 043418 (2008).

A 24.3 Do 11:15 VMP 6 HS-C

dynamical structure factor and spin-density separation for a weakly-interacting two-component Bose gas — •Ming-Chiang Chung — Academia Sinica Taiwan

We show that spin-density separation in a Bose gas is not restricted to 1D but also occurs in higher dimension. The ratio (α) of the intra-species atom-atom interaction strength to the inter-species interaction strength, strongly influences the dynamics of spin-density separation and the elementary excitations. The density wave is phonon-like for all values of α. For $\alpha < 1$, spin wave is also phonon-like. The spin waves have a quadratic dispersion in the $\alpha = 1$ coupling regime, while in the phase separated regime ($\alpha > 1$) the spin waves are found to be damped. The dynamical structure factor (DSF) reveals two distinct peaks corresponding to the density and spin waves for $\alpha \leq 1$. For $\alpha > 1$ there is only one DSF peak corresponding to the density wave.

A 24.4 Do 11:30 VMP 6 HS-C

Coherent control and matter wave interference of single atoms — •Andreas Steffen, Michał Karski, Leonid Förster, Jai-Min Choi, Tan Wang, Artur Widera, and Dieter Meschede — Institut für angewandte Physik, Bonn, Deutschland

We report on recent progress for coherent spin-dependent transport of neutral atoms, paving the way to creating entanglement via controlled collisions.

We store a small number of ultracold caesium atoms in a state-selective 1D optical lattice. We are able to manipulate and detect atoms with close to nearest-neighbor precision. By displacing the potentials for two spin states, vibrational sidebands appear in the microwave spectrum, which we have employed to cool the atoms to the vibrational ground state in the axial direction. We have also achieved coherent state-selective transport over multiple lattice sites. This opens up a number of applications, such as the single trapped atom interferometer and the quantum walk with a single atom.

We will present latest experimental results.

A 24.5 Do 11:45 VMP 6 HS-C

Ultracold Atoms in Superconducting Microtraps — •Helge Hattermann, Daniel Cano, Brian Kasch, Florian Jessen, Max Kahmann, Dieter Kölle, Reinhold Kleiner, Claus Zimmermann, and József Fortágh — Center for Collective Quantum Phenomena and their Applications, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen

We present recent measurements on ultracold atoms in a superconducting magnetic mictrotrap. It is shown that the Meissner effect plays a critical role in determining the near field trap shape. Our experimental setup consists of a ^{87}Rb BEC apparatus and an optical tweezers for transporting an ultracold atom cloud 44mm to the surface of a helium flow cryostat at 4 K. Here, the atoms are loaded into a magnetic microtrap formed by a 125 micron diameter superconducting niobium wire. The influence of the Meissner effect on the trap geometry has been evaluated both theoretically [1] and experimentally [2]. The Meissner effect shortens the distance between the trap and the superconductor, reduces the magnetic field gradients and lowers the trap depth. We also observed a temperature dependence of the magnetic field exclusion from the superconducting wire. Based on our measurements, we discuss future strategies for the manipulation of ultracold atoms in superconducting traps.

[1] D. Cano *et al.*, Phys. Rev. A 77, 063408 (2008)
[2] D. Cano *et al.*, Phys. Rev. Lett. 101, 183006 (2008)

A 24.6 Do 12:00 VMP 6 HS-C

Towards a finite system of degenerate fermions — Timo B. Ottenstein, Thomas Lompe, Andre N. Wenz, •Gerhard Zürn, and Selim Jochim — Max Planck Institut für Kernphysik, Heidelberg, Germany

We report on our approach towards a finite ensemble of degenerate fermionic ^{6}Li atoms. In this system it will be possible to study the crossover from mesoscopic physics to the thermodynamic limit. One of the first phenomena to study is the formation of shell structures in a two component mixture with tunable interactions. ^{6}Li is especially well suited due to the easy tunability of the interparticle interaction by means of Feshbach resonances.

The starting point of such experiments will be our BEC of ^{6}Li Feshbach molecules in an optical dipole trap. For preparing an ensemble of few atoms a precise control of the particle number is essential. This requirement can be fullfilled by transferring the sample into a micrometer sized trap with high trapping frequencies which is realized by a tightly focused laser beam. So far we have determined the parameters of our micro trap in an external test setup with satisfying results.

The next step will be the integration of the micro trap into the existing setup and testing its performance.